Design and Analysis of Wideband Microstrip MIMO Antenna for Wireless Communication

Synopsis of the Research Proposal

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Wideband MIMO microstrip antennas have become essential building blocks in modern wireless communication systems, where high data rates, reliable connectivity, and compact device integration are key requirements. By combining the versatility of microstrip antennas with the spatial diversity and capacity enhancement offered by MIMO technology, these antenna systems enable efficient spectrum utilisation in crowded wireless environments.

1. Introduction

A microstrip antenna typically consists of a metallic patch printed over a dielectric substrate with a ground plane on the opposite side. Its advantages lightweight profile, low fabrication cost, planar geometry, and ease of integration with RF circuits, make it highly suitable for portable and embedded applications. When extended to wideband operation, MSAs support multiple wireless standards across a broad frequency range, reducing the need for separate antennas in a single device. Three primary structural layers make up a microstrip patch antenna, as shown in Figure 1. [1]-[4]

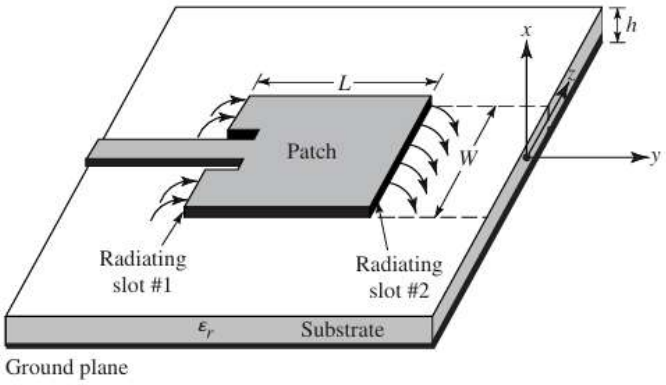


Figure 1: Microstrip antenna [1]

- The radiating patch on top,
- A dielectric substrate in the middle, and
- A ground plane at the bottom.

The performance of the antenna is greatly influenced by the substrate, which is located between the patch and the ground plane. According to the intended use and performance requirements, the patch is usually constructed of copper and can be shaped in a variety of ways, such as triangular, square, rectangular, circular or elliptical.

2. Antenna Design Equations and Fringing Effects

Fringing effects in microstrip patch antenna design refer to the extension of electric fields beyond the radiating patch's physical edges. This effect results from the patch's limited size, which hinders the total containment of electromagnetic fields beneath the conductor and is essential to the radiation mechanism of the antenna. Many structural factors influence the degree of fringing, chief among them the dielectric constant ($\varepsilon_r \varepsilon_r$) of the substrate material and the ratio of the patch's length to the substrate height (L/h) [5-6]. Since fringing effects have a direct impact on the effective electrical length of the patch and, consequently, the resonant frequency, impedance matching, and radiation characteristics of the antenna, precise modelling and compensation for them are crucial stages in the design process.

Fringing fields alter the resonance frequency by making the microstrip antenna appear to be electrically longer than its actual dimensions. Especially, the antenna resonates at a frequency that is somewhat lower than what its physical size would indicate. Because of this, fringing is essential for precisely forecasting antenna performance. To account for these effects in microstrip lines which are structurally similar a concept called the effective dielectric constant (ε_{reff}) is introduced. This value represents an average dielectric constant, acknowledging that the electromagnetic wave propagates partially in the substrate and partially in the air above it. The effective dielectric constant typically falls between 1 (air) and ε_r (substrate), and it shifts closer to $\varepsilon_r$as the operating frequency increases because more of the field becomes concentrated in the substrate. Overall, understanding and compensating for fringing effects is essential for the accurate design and modelling of microstrip patch antennas.

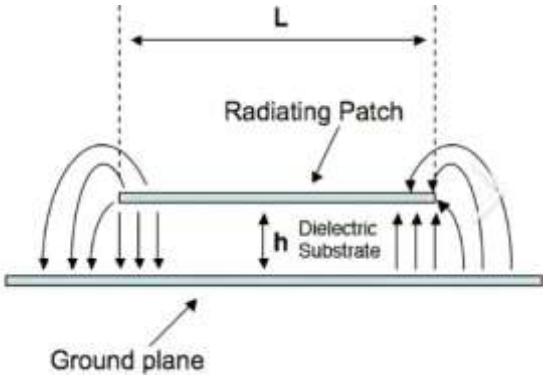


Figure 2: Fringing effects in microstrip patch antenna[1]

The most critical step in antenna development is the finalisation of design specifications, which are determined by the intended application. Antenna specifications are typically guided by system-level requirements, which are established through comprehensive analysis and simulation of the overall system,such as a 5G network or a radar application by a system

architect or engineer. These specifications are critically informed by the operational context; for instance, the performance criteria for a wireless mobile communication antenna differ substantially from those governing satellite or radar antenna systems, reflecting their distinct functional and environmental demands. Following are the design equations, as described in [1], are depicted as follows:

1) Specify ε_r and h of substrate, the desired resonant frequency f_r, and the impedance Z_c, feed of the feeding transmission line.

2) Calculate the width of the patch using transmission line equations

$$W = \frac{2}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad \text{(i)}$$

(Selected to provide high radiation efficiency.) Ideally, the patch width (W) should be smaller than its length (L), i.e., W < L, to ensure operation in the fundamental mode only. In practice, W > L may be employed if the patch is appropriately excited, so as to avoid excitation of higher-order modes that are dominant when W > L. The width can be adjusted, provided that the ratio W/L remains less than 2, in order to prevent a decrease in aperture efficiency.

3) Calculate the effective dielectric constant

$$\varepsilon_{r,eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1 + 12\frac{h}{w}\right] \quad \text{(ii)}$$

4) Calculation of length extension due to fringing effect

$$\Delta L = 0.412h\,\frac{\left(\varepsilon_{r,eff}+0.3\right)\left(\frac{W}{h}+0.624\right)}{\left(\varepsilon_{r,eff}+0.3\right)\left(\frac{W}{h}+0.624\right)} \quad \text{(iii)}$$

5) Calculate the effective length.

$$L_{eff} = \frac{C}{2f_r\sqrt{\varepsilon_{r,eff}}} \text{ and } \lambda = 2L_{eff} \quad \text{(iv)}$$

6) Calculate the patch length L and calculate and check that W/L < 2. If necessary, reduce W calculated in step 2 to be slightly less than 2L.

$$L = L_{eff} - 2\Delta L = \frac{\lambda}{2} - 2\Delta L \quad \text{(v)}$$

Integrating MIMO techniques further enhances system performance by improving channel capacity, minimizing multipath fading, and ensuring robust link quality. To realize effective wideband MIMO MSAs, careful attention is given to patch geometry, feed configuration, mutual coupling reduction, and substrate selection. These design considerations allow antenna arrays to maintain good impedance matching, high isolation, and stable radiation characteristics across the operational bandwidth.

Overall, wideband MIMO MSAs serve as a compact, efficient, and scalable solution for next-generation wireless technologies, including 4G/5G, WLAN, IoT, and emerging broadband communication systems.

3. Characteristics of Microstrip Antennas (MSAs)

Microstrip antennas have evolved as one of the most preferred radiators in modern wireless systems due to their attractive electrical and mechanical features. Although they offer several benefits over traditional microwave antennas, they also come with a few limitations that impact their performance as presented in [7]-[8]. A brief overview of their advantages and disadvantages is presented below.

4. Advantages

Microstrip antennas offer multiple strengths that make them suitable for a wide range of RF and communication applications:

1. Compact and lightweight: Their thin, planar structure makes them easy to install, especially in portable and low-profile devices.
2. Conformal design: MSAs can be fabricated to follow the curvature of the mounting surface, making them ideal for aerospace and wearable applications.
3. Economical fabrication: Since they use standard printed-circuit technology, they can be produced in large quantities at a low cost.
4. Easy integration: Their planar geometry allows seamless integration with microwave integrated circuits on the same substrate.
5. Flexible polarisation options: They support both linear and circular polarisation depending on the patch configuration.
6. Suitability for compact systems: Their small size makes them ideal for mobile and personal communication devices.
7. Multi-band capability: With appropriate design techniques, MSAs can operate at dual or even triple frequency bands.

5. Disadvantages

1. Despite their appealing features, MSAs face certain limitations that can restrict their performance:

2. Narrow bandwidth: Conventional MSAs typically offer only about 1–5% bandwidth, which is often insufficient for broadband systems.
3. Relatively low gain: Their radiation efficiency is lower than that of many conventional antennas.
4. Limited power handling: The thin structure restricts their capability to handle high power levels.

6. Problem Statement

Modern wireless communication systems demand antennas that can operate over wide frequency ranges to support multiple standards, high data rates, and rapidly changing spectrum requirements. Conventional microstrip antennas, although compact and easy to fabricate, inherently suffer from narrow bandwidth, limited gain, and restricted radiation performance. These limitations make them unsuitable for emerging broadband applications such as 4G/5G, Wi-Fi 6/7, UWB, and IoT platforms, where seamless multi-band operation and stable radiation characteristics across wide frequency spans are essential. Therefore, the technical challenge is to design wideband microstrip antennas that overcome the intrinsic bandwidth limitations of traditional MSAs while maintaining low profile, easy integration, and low fabrication cost. Additionally, as user devices simultaneously require high throughput and reliable connectivity, there is a growing need to evolve wideband MSAs into MIMO configurations that enhance channel capacity and link robustness.

7. Motivation for Wideband Microstrip Antennas

The motivation to develop wideband MSAs arises from several key technological and practical needs:

- **Support for multiple wireless standards:**

Modern devices must operate across several frequency bands (LTE, Wi-Fi, 5G NR, Bluetooth, UWB). A wideband antenna can replace multiple narrowband antennas, reducing size and complexity.

- **Higher data-rate demand:**

Wideband antennas enable higher channel capacity and faster data transmission, essential for broadband services and real-time applications such as video streaming and AR/VR.

- **Compact and low-profile design requirements:**

Despite being wideband, the antenna must remain small, lightweight, and easy to integrate with compact RF front-ends.

- **Improved system reliability:**

A broad operating bandwidth provides tolerance against detuning effects caused by device casing, user interaction, manufacturing variation, and environmental factors.

- **Future-proof communication devices:**

As spectrum allocation evolves, wideband antennas ensure compatibility with future wireless bands without major hardware redesign.

Because of these factors, enhancing the bandwidth of MSAs has become a major research direction, with techniques such as slotting, stacked patches, parasitic elements, defected ground structures, and metasurface loading widely explored.

8. Motivation for Wideband MIMO MSA

While a wideband antenna ensures broad frequency coverage, it still cannot meet the growing expectations for high spectral efficiency, reduced fading, and stable link quality. This is where MIMO technology becomes essential.

- **Enhanced data throughput:**

MIMO systems use multiple antenna elements to transmit and receive simultaneously, significantly increasing channel capacity without increasing spectrum requirements.

- **Mitigation of multipath fading:**

In realistic environments, signals arrive via multiple paths. MIMO diversity improves signal reliability and reduces deep fades.

- **Better performance:**

Wideband MIMO antennas support high user density and maintain performance in crowded environments, which is crucial for 5G, IoT hubs, and smart devices.

- **Compact integration:**

Using microstrip technology, multiple antenna elements can be integrated on a single substrate while maintaining a low profile.

- **Enabling next-generation wireless systems:**

Technologies like massive MIMO, beamforming, and spatial multiplexing rely on robust wideband MIMO antennas. Without wideband capability, these advanced physical-layer techniques cannot be fully realised.

9. Background of MIMO antenna

Wideband MIMO antennas have become a key component of modern wireless communication systems because today's networks must support extremely high data rates, large user density, and seamless connectivity across multiple frequency bands. As wireless traffic continues to grow exponentially,global data usage per smartphone is rising from about 19 GB per month in 2023 to an expected 46 GB by 2028. The need for highly efficient antenna systems has never been greater. MIMO technology addresses this demand by using multiple antennas at both the transmitter and receiver ends to exploit spatial diversity, improve link reliability, and significantly increase channel capacity.Wideband MIMO antennas extend these benefits by operating across large portions of the spectrum, enabling compatibility with various wireless standards such as LTE, Wi-Fi, 5G NR, and emerging beyond-5G (B5G) applications. Their ability to cover wide frequency ranges in a single compact structure makes them ideal for modern multi-band user devices and base stations. Wideband MIMO systems not only improve spectral efficiency but also help maintain stable performance under changing environmental and propagation conditions.

Over the years, MIMO technology has evolved rapidlyfrom early spatial diversity concepts in the 1990s, to 2×2/4×4 MIMO in early 2000s Wi-Fi and 4G LTE, to massive MIMO with tens or hundreds of antennas in 5G NR. These advancements have enabled better coverage, higher throughput, and more reliable communication. Recent 5G networks further integrate advanced techniques such as beamforming, full-dimension MIMO, and distributed massive MIMO, paving the way for scalable and efficient future 6G systems [9].

In 5G specifically, MIMO antennas play a central role across all three major use cases:

- **eMBB:** High-speed broadband services, where spatial multiplexing boosts data rates for applications like streaming, AR/VR, and cloud gaming.
- **uRLLC:** Ultra-reliable, low-latency communication for autonomous vehicles and industrial automation, supported by spatial diversity for robust signal reception.
- **mMTC:** Massive machine-type communication, often enhanced through distributed massive MIMO, where many access points cooperate to serve a large number of devices efficiently.

Overall, the progression toward wideband MIMO antenna systems is driven by the need for higher capacity, improved reliability, and broad multi-band operation. These systems form the backbone of next-generation wireless networks and continue to evolve to meet the growing demands of global connectivity.

10. Literature Review

A review of previously reported antenna designs reveals significant progress in developing compact radiators with wider bandwidths and improved radiation characteristics. In this section, a detailed study of the existing wideband and MIMO antennas is carried out to structure the objectives of the work.

The work [10] presented a ten-element mm-wave MIMO radiator for the n258 band, aimed to achieve high isolation and improved cross-polar radiation. A CPW-fed elliptical radiator with a defected ground and a reflector, it attains 35 dB isolation. Impressive diversity metrics, such as very low ECC, minimal CCL, were presented. The fabricated prototype results validate the simulated results.

The manuscript in [11] presented an inverted F radiator aligned with a parasitic patch, covers the frequency range of 23.7 to 28.2 GHz. Presented radiator extended to array configuration, attains a peak gain of 11 dB.

This study [12] introduced a quad-port MIMO radiator implemented on a Rogers 5880 substrate, having permittivity of 2.2 and a thickness of 0.508mm. The proposed radiator covers the operating range from 26.5 to 30.4 GHz, and attains a peak gain of 11 dBi. The overall geometric configuration of the antenna are 28.3mm × 28.3mm × 0.508mm. Defected ground structure and capactive loading using split ring resonator are utilized to improve the isolation. This results in an isolation of -40dB among the ports, accomplished a high radiation efficiency of 96%. The MIMO diversity parameters of the antenna exhibit excellent performance.

The study [13] presented a dual-band MIMO radiator operate at millimeter-wave (mmWave) bands 28 GHz and 38 GHz respectively. It covers the frequency ranges of 21.4–29.35 GHz and 36.6–40.4 GHz, respectively. A metamaterial layer is incorporated between the patches which improves the isolation to -39 dB at 28 GHz and -38 dB at 38 GHz. The proposed radiator is implemented using a Rogers RT5880 substrate with a relative permittivity of 2.2

and a thickness of 0.508 mm. The MIMO performance parameters for this antenna are noteworthy.

This study[14] introduced a millimetre-wave (mm-wave) rdiatoraimed to enhance gain for the FR-II bands. The design utilized a rectangular slot that covers the operating band 28 GHz spaning from 26 GHz up to 29.8 GHz. The FSS reflectors is incorporated which improve the desired gain approximately more than 5.3 dBi. Also, FSS integration improve the bandwidth, from 25.5 GHz to 30.8 GHz. At 28 GHz, it attains a realized gain of around 10.3 dBi and a radiation efficiency of approximately 90%.

This study [15] introduced a ultra-wideband (UWB) MIMO Vivaldi radiator. The proposed design consists of two parallel-radiating Vivaldi elements with complementary Split Ring Resonators (CSRRs) positioned between them. The antenna is implemented on a 0.254-mm Rogers RT5880 substrate having permittivity of 2.2 and a loss tangent of 0.0009. The presented radiator covers the impressive bandwidth. It exhibits a realized gain of 13.9 dB and a maximum efficiency of 98.8%. Furthermore, the MIMO performance parameters are analysed, resulting in an correlation coefficient (ECC) below 0.0024 and a Diversity Gain (DG) exceeding 9.9988.

The work [16] introduced a circularly polarized radiator operating at 28 GHz. The radiator is constructed using Roger RT/Duroid 6002, with a thickness of 0.79 mm. The dimensions of the two-port MIMO antennas are 20.5 mm × 12 mm × 0.79 mm. The presented radiator shows wideband coverage ranging from 25.5 GHz to 29.5 GHz. It exhibits excellent isolation, with values below -35 dB within the operational band. The peak gain of the antenna is measured at 7.75 dB. Importantly, the proposed design achieves a high radiation efficiency of over 97.75% across the entire bandwidth.

The study [17] slot radiator with frequency selective surface was proposed to improve the radiational characterstics. FSS improve the gain by approximately 5.3 dBi. Without FSS operation bandwidth was 26 GHz to 29.8 GHz with an $S11 \leq -10$ dB, and attained a gain of 4.5 dBi, and a radiation efficiency of around 93%. With FSS operational bandwidth slightly improves from 25.5 GHz to 30.8 GHz and gain of around 10.3 dBi at 28 GHz.

The work [18] proposed a compact meta surface wideband MIMO radiator for sub-6GHz wireless communication systems. Modified patch with a partially ground, and a meta surface enhanc its performance. It covers the frequency range from 3.11 to 7.67GHz yield a gain of 8 dBi. The suggested MIMO prototype implemented on a low loss Rogers RT5880 substrate.

The manuscript [19] introduced a flexible inverted L-shaped radiator with a plus-shaped geometry housed inside a circular ring, with a partial ground.The presented radiator fabricated on a flexible polyimide substrate. Design was extended to 8-port MIMO with a common ground achieved a impedance bandwidth of 3.05–3.74 GHz. The antenna exhibits a gain of >2.2 dBi within the resonant band under normal conditions, which deteriorates to under 2 dBi when the antenna is bent along the X-axis. The efficiency of the antenna for all conditions is well above 95%.

The study [20] presented microstrip-line fed monopoles, with EL slot and stubs coupled to the partial ground to improve impedance matching and radiation characteristics. An un-protruded multi-slot (UPMS) isolating element is introduced between the closely spaced antenna elements to improve the performance.

This manuscript [21] describes the MIMO radiator with a HP-shaped design operated at a wideband of 36.83-40.0 GHz. The design achieved a peak gain of 6.5 dB, and maximum element-isolation of -45 dB. The radiation efficiency of the proposed design is above 80% at the desired frequency band. The analysis of performance metrics such as ECC, diversity gain, and CCL demonstrate the good characteristics of the proposed design across the operating band.

The study [22] introduced a compact MIMO design with hexagonal-shaped slotted ground. The radiator implemented using on a RT duroid 5880 substrate. The proposed radiator has impedance bandwidth of 30.47% covers the band 26.7 GHz to 36.3 GHz.

This study [23] presented a dielectric resonator antenna arrays, aimed to enhance isolation. The proposed DR-Magnetoelectric-dipole printed on a 0.813 mm thick Rogers RO4003C substrate (with a relative permittivity of 3.55 and a loss tangent of 0.0027). Impedance bandwidth of the proposed DRA is 16.3% (3.18–3.75 GHz)and gain of 8.2 dBi achieved.

The work [24] presented a MIMO radiator covers the frequency range from 26.7–36.3 GHz. The proposed quad-port MIMO antenna has excellent mutual coupling of -18 dB with radiation efficiency of more than 95% with a peak gain of 5.8 db. ECC below 0.027 and maximum DG of 9.99dB has achieved.

The work presented a glue less MIMO DRA[25] for X-band applications. The proposed radiator covers frequency range of 8.2-9.02 GHz with gain of 6.2 dB. Design utilized a

aperture coupled feed and isolation of −14 dB is obtained. The performance parameters ECC and efficiency below 0.29 and 90% respectively

In this manuscript [26], circular-shaped cavity backed substrate integrated waveguide (SIW) radiator was designed. The presented SIW radiator implemented on arlon substrate. The FSS is incorporated as a superstrate for gain enhancement from 4 dBi to 7.1 dBi.

This work proposed a four-port alumina based dielectric resonator [27] MIMO radiator fed through aperture feeding to achieve dual-band resonance. The design mounted on a standard low-cost FR-4 substrate having a dielectric constant of 4.4. The antenna attained peak gain of 5.8 dBi and 6.2 dBi, and an efficiency of 88.6% and 90.2% at 3.3 GHz and 3.9 GHz, respectively.

The study [28] proposed a MIMO radiator consisting of two orthogonal monopole elements with a partial ground. An artificial magnetic conductor (AMC) layer improved the gain by 55% over a frequency band of 26-31.5 GHz. Also AMC improves the radiation effciiency 93.5% to 90%.The diversity parameters like ECC achieved below 0.005, the DG is higher than 9.97 CCL is lower than 0.4 bit/s/Hz within the operating frequency bands.

The study [29] described an ultrawideband MIMO radiator smart phones, consisting of two planar inverted-F antennas (PIFAs) merged into a PIFA-pair. The PIFA-pair has a wide bandwidth of 78% and can cover the 5G NR frequency bands and LTE band 46. The design exhibits a bandwidth of 78%, isolation of more than 10 dB, ECCs lower than 0.06, and total efficiency ranging from 40% to 78%. The introduction of an inverted-T shaped open-slot in the PIFA helps widen the bandwidth by involving more resonant modes.

The study [30] described a flexible, transparent, wideband four-element MIMO radiator that uses conductive oxide material AgHT-4 and Melinex substrate to achieve optical transparency. The antenna has a common ground and employs circular stub-loaded C-shaped resonators. The inter-element isolation level is greater than 15 dB, and the antenna provides a −10 dB impedance bandwidth of 2.21-6 GHz (92.32%). The maximum gain is 0.53dBi, and the minimum efficiency is 41%, which is satisfactory considering the flexible structure. MIMO diversity parameter ECC lower than 0.016 isolation without using any decoupling structure is achieved 15dB and gain of 0.53 dBi reported.

This menuscript [31] proposed a MIMO radiator along with metamaterial structure enhances the miniaturization and performance while ensuring proper MIMO system operation with a

small spacing between radiating elements. The metamaterials used considerably reduce the coupling of multi-antennas, and the application of split-ring resonators (SRRs) on the antenna patch plane increases antenna performance. The antenna system can cover the whole UWB 2.1-18 GHz and mutual coupling below -20 dB. The proposed design presented a good diversity performance with ECC < 0.1, DG > 9 dB, and efficiency around 89%. The maximum gain value obtained is approximately 6.5 dB, and its minimum value is 1.43 dB for the frequency of 2 GHz.

The study [32] proposed a meta surface-based MIMO comprised of a microstrip-fed radiating patch with meta surface implemented on identical Rogers RO4003C substrates with a thickness 1.524 mm, $\varepsilon r = 3.55$ and $\tan\delta = 0.0027$. The single element antenna exhibits a wideband operational bandwidth from 3.27 to 3.82 GHz. The proposed 2x2 MIMO provides 15.9% of 10 dB impedance bandwidth from 3.3 to 3.87 GHz with a peak gain of 8.72 dBi. The proposed MIMO offers diversity performance, with isolation greater than 32dB, ECC <0.001, and diversity gain of 9.99 dB.

The manuscript [33] introduced a low-profile multi-slotted patch antenna for LTE and sub-6 GHz 5G communication applications. The radiator consist of three slots within the patch, which enhances the capacitive effect and allows for a wide operating bandwidth ranging from 3.15 to 5.55 GHz. The average measured gain of the antenna is 2.35 dBi with a maximum of 2.69 dBi, and efficiency of 79.6%.

In this study [34] 2 element MIMO presented with defected ground structure that operate at 27.7–31.4 GHz. Diversity parameters ECC is much smaller than 0.5, CCL less than 0.1bits/s/Hz maximum isolation is achieved 35.8dB, gain of 5.42dB. Radiation efficiency is better than 84%.

11. Research Gaps:

I. As per the available literature, the designs of wideband antenna covering the 5G FR-I and FR-II bands exhibits low gain.

II. In the MIMO configuration covering the 5G FR-I and FR-II band the vital performance parameters are not fully explored and analysed such as:
   - Envelope Correlation Coefficient (ECC),
   - Diversity Gain (DG),
   - Mean Effective Gain (MEG),

- Channel Capacity Loss (CCl)

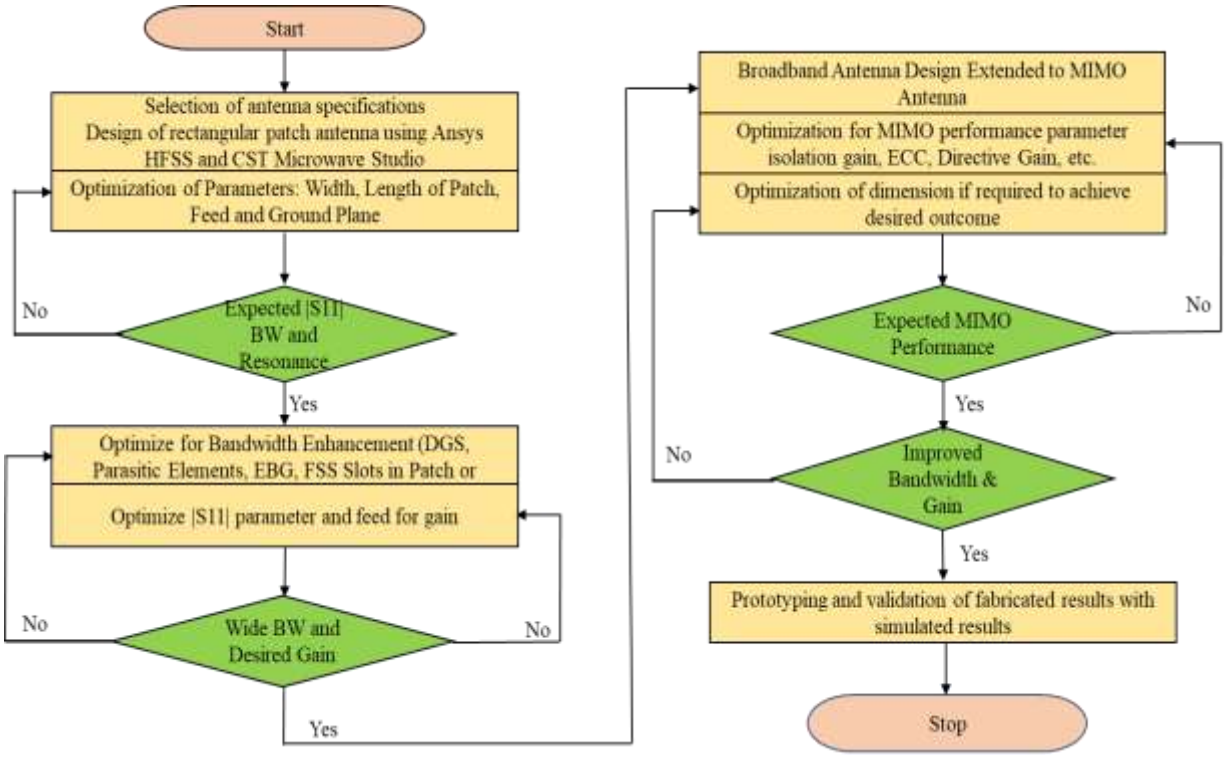
12. Research Objectives

1. Design and performance analysis of a wideband MIMO microstrip patch antenna for 5G communication systems.
2. Fabrication and measurement of a wideband MIMO microstrip patch antenna intended for 5G applications.
3. Validation of simulated results with measured data for the developed wideband MIMO microstrip patch antenna.

13. Research Methodology

The proposed work on wideband MIMO antenna will cover simulation analysis, fabrication of prototype, measurements of fabricated prototype and comparisons of simulated results with the fabricated prototype of antenna. Simulation of the proposed MIMO antenna will be performed on CST Microwave Studio. Based on the simulation results, an antenna will be fabricated on suitable substrate material RT Duriod 5880 or glass epoxy FR-4 Substrate which is readily available and cost-effective.

(a) Design Flow Chart:


Start
Selection of antenna specifications
Design of rectangular patch antenna using Ansys HFSS and CST Microwave Studio
Optimization of Parameters: Width, Length of Patch, Feed and Ground Plane
No
Expected |S11| BW and Resonance
Yes
Optimize for Bandwidth Enhancement (DGS, Parasitic Elements, EBG, FSS Slots in Patch or
Optimize |S11| parameter and feed for gain
No
Wide BW and Desired Gain
No
Yes
Broadband Antenna Design Extended to MIMO Antenna
Optimization for MIMO performance parameter isolation gain, ECC, Directive Gain, etc.
Optimization of dimension if required to achieve desired outcome
Expected MIMO Performance
No
Yes
No
Improved Bandwidth & Gain
Yes
Prototyping and validation of fabricated results with simulated results
Stop

Designing a patch antenna involves several steps, including selecting the frequency of operation and determining the dielectric materials and thickness for the antenna. Here are the design steps in detail:

- Frequency Selection
- Substrate Selection
- Dielectric Thickness:
- Patch antenna geometry and analysis
- EM Simulation and Optimization

(b) Fabrication Considerations:

Consider the fabrication technique suitable for the chosen substrate and patch antenna design, such as PCB manufacturing or microstrip technology. Determine the manufacturing tolerances and capabilities of the chosen fabrication method. Ensure that the selected substrate material and thickness are compatible with the fabrication process. Consult with manufacturers or fabricators to confirm the feasibility of the chosen design and fabrication approach.

(c) Iterative Refinement and Optimization:

Based on the prototype testing, identify any deviations or areas for improvement in the fabricated patch antenna. Modify the design parameters, such as patch dimensions, feeding techniques, or substrate properties, to address any issues or optimize performance. Repeat the fabrication and testing steps if further iterations are required to meet the desired specifications.

14. Tentative Structure/Chapter Outline of the thesis:

This thesis will contain five chapters organized as follows:

Chapter one: The aim, objectives, motivations, applications and drawbacks of MIMO planner antenna for 5G wireless communication.

Chapter two: It Presentan overview of the microstrip planar antennas and their characteristics. Literature review related to wideband MIMO antenna and discuss the vital parameters affecting their performance, with feeding techniques used in planner antennas.

Chapter three: Introduces the MIMO antenna performance parameter in detail and effect of the parametrical analysis.

Chapter four: Introduces the design and analysis of MIMO planner antenna in desired band and with incorporating bandwidth and gain enhancement techniques to improve the performance of antenna.

Chapter five: Will Summarize the conclusions drawn from the research reported in this thesis. The exploratory ideas for future work in the area of antenna design will also be suggested.

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